



US009452791B2

(12) **United States Patent**
Hamner et al.

(10) **Patent No.:** **US 9,452,791 B2**
(45) **Date of Patent:** **Sep. 27, 2016**

(54) **HYDRO-FORM BONDED BOLSTER**

(56) **References Cited**

(71) Applicant: **Continental Structural Plastics, Inc.**,
Auburn Hills, MI (US)

U.S. PATENT DOCUMENTS

(72) Inventors: **Kim Robert Hamner**, Troy, MI (US);
Pat Short, Troy, MI (US)

5,070,717 A * 12/1991 Boyd et al. 72/55
5,729,463 A 3/1998 Koenig et al.
5,791,673 A * 8/1998 Patterson 280/281.1
5,953,945 A 9/1999 Horton
6,227,321 B1 5/2001 Frascaroli et al.

(73) Assignee: **Continental Structural Plastics, Inc.**,
Auburn Hills, MI (US)

(Continued)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 0 days.

OTHER PUBLICATIONS

Bolster-LCA-Infographic "Automotive Lightweighting With Plas-
tics Results in Reduced Fuel Use and CO2 Emissions".

(21) Appl. No.: **14/289,242**

Primary Examiner — Kiran B Patel

(22) Filed: **May 28, 2014**

(74) *Attorney, Agent, or Firm* — Avery N. Goldstein; Blue
Filament Law, PLLC

(65) **Prior Publication Data**

US 2014/0354013 A1 Dec. 4, 2014

Related U.S. Application Data

(60) Provisional application No. 61/827,819, filed on May
28, 2013.

(51) **Int. Cl.**

B60J 7/00 (2006.01)

B62D 29/00 (2006.01)

B62D 25/08 (2006.01)

B21D 26/033 (2011.01)

(52) **U.S. Cl.**

CPC **B62D 29/005** (2013.01); **B62D 25/085**
(2013.01); **B21D 26/033** (2013.01); **Y10T**
29/49622 (2015.01)

(58) **Field of Classification Search**

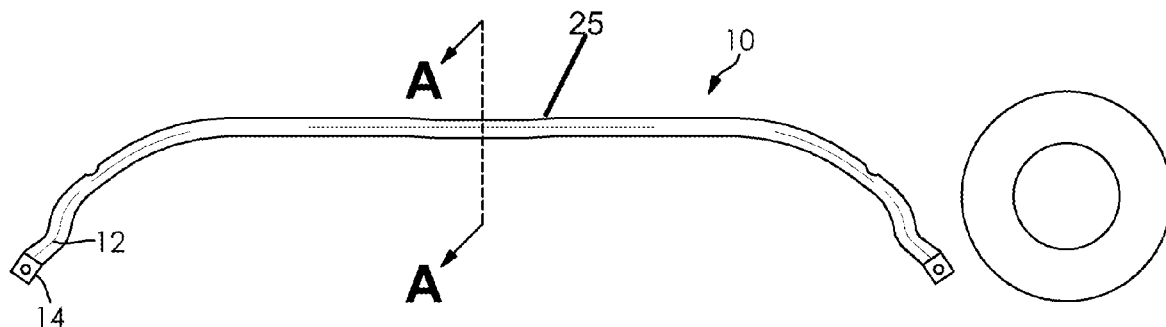
CPC B60G 9/003; B60G 11/27; B60R 21/045;
B60R 2021/0051; B61D 3/184; A61J
15/0015; A61J 15/0026; A61J 15/0038;
A61J 15/0057; A61B 17/3415

USPC 296/193.02
See application file for complete search history.

(57) **ABSTRACT**

A vehicle front end load bearing bolster is provided with improved structural performance and a lower component weight, while also minimizing material, tooling, and production costs. The front end assembly is formed with a hydro-formed cross car reinforcement tube secured or bonded with mechanical fasteners and room temperature adhesive to a bolster, thereby improving stress distribution and increasing cross car system stiffness. The bonded hydro-form tube/bolster assembly provides increased torsion stiffness and dimensional stability to the vehicle frame. The hydro-formed cross car reinforcement tube have flattened terminal ends with apertures for integrated attachment to a bolster. The hydro-formed cross car reinforcement tube is formed of aluminum, brass, carbon, steel, stainless steel, copper and high strength alloys. The bolster is formed of high strength plastics and composites including sheet molding compounds (SMC), bulk molding compounds (BMC), and thermoplastic compounds such as glass mat thermoplastic (GMT) and direct long fiber thermoplastic (DLFT).

6 Claims, 3 Drawing Sheets



(56)

References Cited

U.S. PATENT DOCUMENTS

6,428,046	B1	8/2002	Kocer et al.	2005/0044913	A1 *	3/2005	Ni et al.	72/61
6,467,834	B1	10/2002	Barz et al.	2007/0074808	A1	4/2007	Deachin et al.	
7,441,819	B2	10/2008	Azzouz et al.	2008/0073926	A1	3/2008	Azzouz et al.	
8,534,109	B1 *	9/2013	Golovashchenko	2008/0133026	A1 *	6/2008	Lei et al.	623/23.54
8,550,545	B1 *	10/2013	Stojkovic et al.	2008/0203768	A1 *	8/2008	Lowe	296/205
9,067,252	B2 *	6/2015	Christianson et al.	2008/0217934	A1 *	9/2008	Hori et al.	293/102
2002/0162224	A1	11/2002	Gabbianelli et al.	2011/0250058	A1 *	10/2011	Suchezky	415/189
2003/0090128	A1 *	5/2003	Seksaria et al.	2012/0047979	A1 *	3/2012	Hertell et al.	72/58
2004/0074095	A1 *	4/2004	Stempien et al.	2012/0242113	A1	9/2012	Yasuhara et al.	
2004/0150208	A1 *	8/2004	Nathan et al.	2012/0285213	A1 *	11/2012	Golovashchenko	72/61
2005/0017543	A1	1/2005	Riley et al.	2012/0312060	A1 *	12/2012	Golovashchenko	72/54
				2013/0069395	A1 *	3/2013	Nusier et al.	296/203.03
				2013/0093163	A1 *	4/2013	Bernart et al.	280/511
				2013/0294936	A1 *	11/2013	Worden et al.	417/53

* cited by examiner

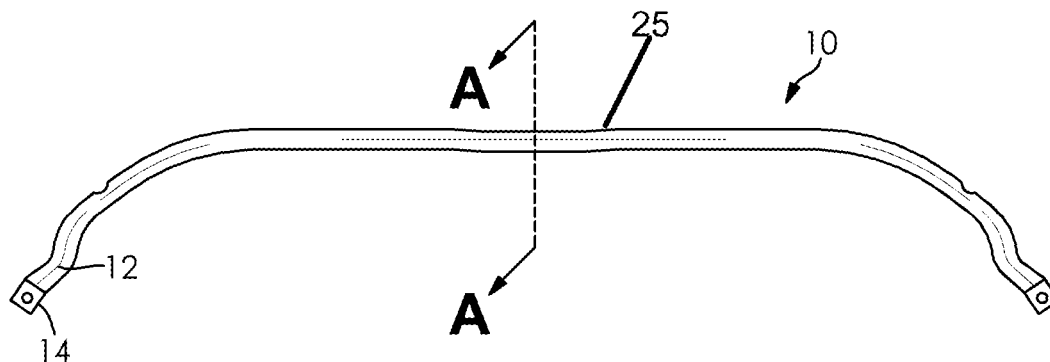


FIG. 1A

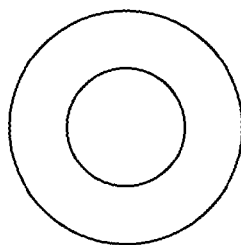


FIG. 1B

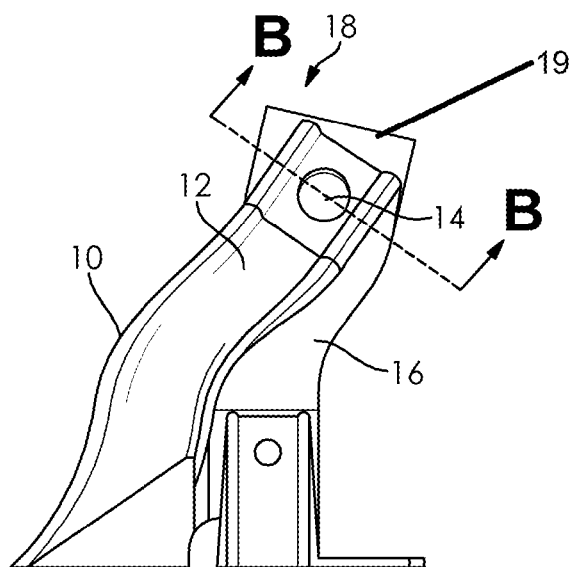


FIG. 2A

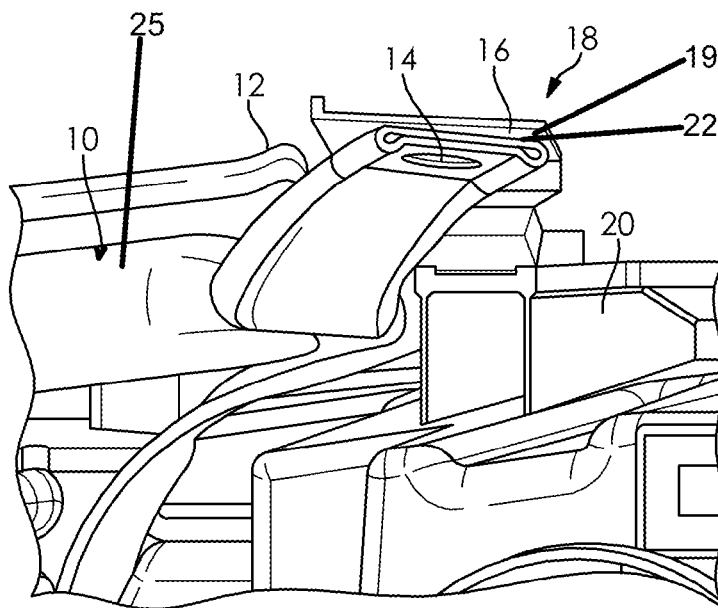


FIG. 2B

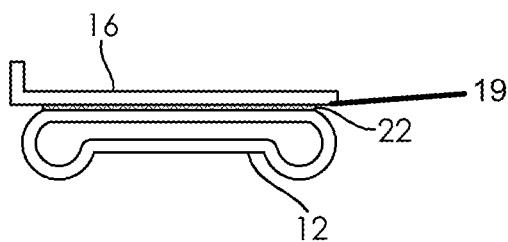


FIG. 3A

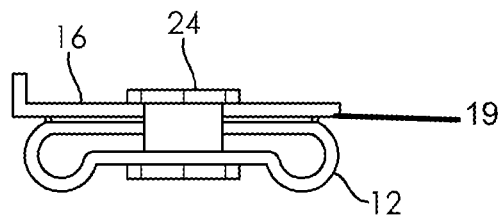


FIG. 3B

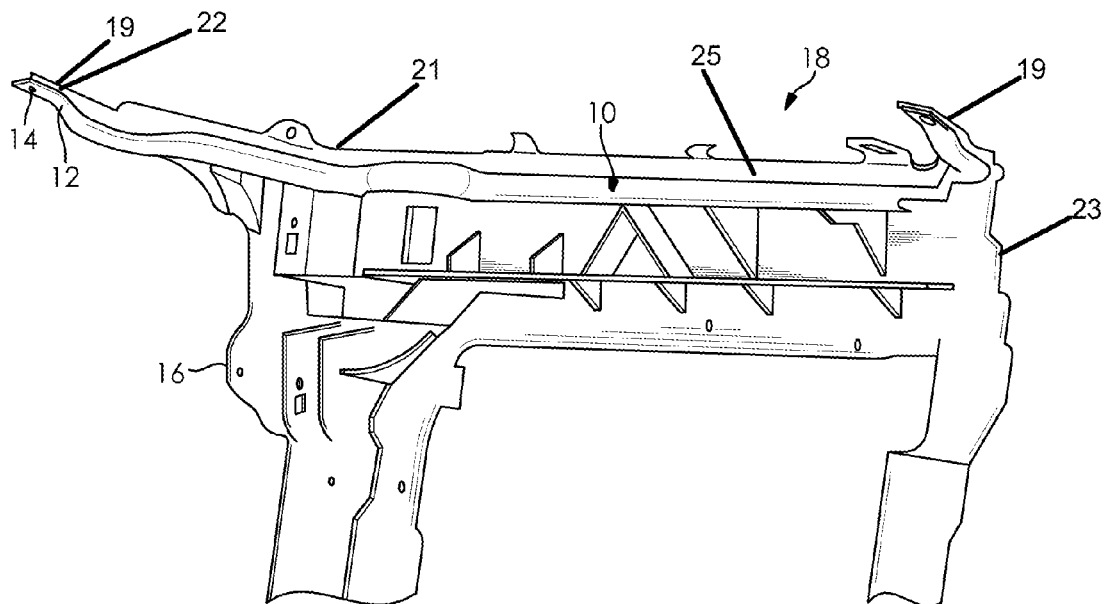


FIG. 4



FIG. 5A
(section C-C)



FIG. 5B
(section C-C)



FIG. 5C
(section C-C)



FIG. 5D
(section C-C)



FIG. 5E
(section C-C)

1

HYDRO-FORM BONDED BOLSTER**RELATED APPLICATIONS**

This application claims priority benefit of U.S. Provisional Application Ser. No. 61/827,819 filed May 28, 2013; the contents of which are hereby incorporated by reference.

FIELD OF THE INVENTION

The present invention in general relates to vehicle front end architecture and, more particularly, to a hydro-form tube with integrated attachment to a bolster.

BACKGROUND OF THE INVENTION

Hydroforming is a cost-effective method of shaping ductile metals such as aluminum, brass, low alloy steels, and stainless steel into lightweight, structurally stiff and strong pieces. Hydroforming is widely used in the automotive industry for making complex shapes that are made possible by the hydroforming process to produce stronger, lighter, and more rigid unibody structures for vehicles, as well as in the shaping of aluminum tubes for bicycle frames. Hydroforming is a specialized type of die forming that uses a high pressure hydraulic fluid to press room temperature working material into a die. In order to hydroform aluminum into a vehicle's frame rail, a hollow tube of aluminum is placed inside a negative mold that has the shape of the desired result. High pressure hydraulic pumps inject fluid at very high pressure inside the aluminum, which causes the aluminum to expand until it matches the mold. The hydroformed aluminum is then removed from the mold. Hydroforming allows complex shapes with concavities to be formed, which would be difficult or impossible with standard solid die stamping. Hydroformed parts can often be made with a higher stiffness-to-weight ratio and at a lower per unit cost than traditional stamped or stamped and welded parts. Virtually all metals capable of cold forming can be hydroformed, including aluminum, brass, carbon and stainless steel, copper, and high strength alloys.

The design of the front end architecture of a vehicle is often influenced by assembly requirements for engine installation, and the vehicle's cooling system module. Furthermore, installation clearances for the front bumper often require splitting the lower bar radiator support away from the bolster, which may require a roll form stamping of the lower bar to meet structural requirements.

Thus, there exists a need for front end load bearing bolsters with improved structural performance and lower component weight, while also minimizing material, tooling, and production costs.

SUMMARY OF THE INVENTION

An inventive vehicle assembly includes a hydro-formed reinforcement tube, and a bolster, where the hydro-formed reinforcement tube is joined with the bolster, and is used as a front end cross car load bearing component joined to a vehicle frame. In an inventive embodiment, the hydro-formed reinforcement tube is bonded to the bolster with an adhesive. In an inventive embodiment, the hydro-formed reinforcement tube has flattened terminal ends with one or more apertures therein for integrated attachment to the bolster, and wherein the apertures are configured for mechanical fasteners. In an inventive embodiment, the hydro-formed reinforcement tube is formed from at least one

2

of aluminum, brass, carbon, steel, stainless steel, copper, and high strength alloys, and the bolster is formed of high strength plastics or composites such as sheet molding compounds (SMC) or bulk molding compounds (BMC), and thermoplastic compounds such as glass mat thermoplastic (GMT) and direct long fiber thermoplastic (DLFT).

A process is provided for producing an inventive vehicle assembly by hydro-forming a cross car reinforcement tube, and joining the reinforcement tube to a bolster with an adhesive and mechanical fasteners.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention is further detailed with respect to the following drawings that are intended to show certain aspects of the present invention, but should not be construed as a limit on the practice of the present invention.

FIG. 1A is a top perspective view of a hydro-form tube with flattened end terminations with apertures for securing mechanical fasteners according to an embodiment of the invention;

FIG. 1B is a sectional view along line A-A through the hydro-form tube of FIG. 1A according to embodiments of the invention;

FIG. 2A is a detail perspective view of the flattened end termination with aperture of the hydro-form tube as depicted in FIG. 1A bonded to a bolster prior to fastener insertion according to an embodiment of the invention;

FIG. 2B is a side perspective view of the bonded hydro-form tube/bolster assembly of FIG. 2A joined with a vehicle frame member; and

FIG. 3A is a sectional view along line B-B through the flattened end termination with aperture of the hydro-form tube bonded to the bolster of FIG. 2A with an adhesive according to an embodiment of the invention;

FIG. 3B is a sectional view along line B-B through the flattened end termination with aperture of the hydro-form tube joined to the bolster of FIG. 2A with a fastener according to an embodiment of the invention;

FIG. 4 is a perspective view of the bonded hydro-form tube/bolster assembly of FIG. 2A including a tie into a hood latch bracket; and

FIGS. 5A-5E are a series of sectional views along line C-C through a portion of the bolster as shown in FIG. 4 showing the high strength plastics and composites used to form the bolster in accordance with embodiments of the invention.

DESCRIPTION OF THE INVENTION

The present invention has utility as a vehicle front end load bearing bolster with improved structural performance and a lower component weight, while also minimizing material, tooling, and production costs. Embodiments of the inventive front end assembly are formed with a hydro-formed cross car reinforcement tube secured or bonded with mechanical fasteners (bolts, rivets, screws, etc.) and room temperature adhesive to a bolster, thereby improving stress distribution and increasing cross car system stiffness. Embodiments of the bonded hydro-form tube/bolster assembly provide increased torsion stiffness and dimensional stability to the vehicle frame. Embodiments of the inventive hydro-formed cross car reinforcement tube have flattened terminal ends with one or more apertures for integrated attachment to a bolster. In embodiments, the hydro-formed cross car reinforcement tube may be formed of aluminum, brass, carbon, steel, stainless steel, copper and high strength

3

alloys. Embodiments of the bolster may be formed of high strength plastics and composites. Composites may include sheet molding compounds (SMC), bulk molding compounds (BMC), and thermoplastic compounds such as glass mat thermoplastic (GMT) and direct long fiber thermoplastic (DLFT).

In a specific inventive embodiment, the hydro-formed cross car reinforcement tube may have a centerline length of 1530 mm with the following part weights 3 lbs at 2.0 mm thick or 2.25 lbs at 1.5 mm thick

Referring now to the figures, FIG. 1A is a top perspective view of a hydro-form tube **10** having a central section **25** with flattened end terminations **12** with apertures **14** for securing mechanical fasteners according to an embodiment of the invention. FIG. 1B is a sectional view along line A-A through the hydro-form tube **10** of FIG. 1A. FIG. 2A is a detailed perspective view of the flattened end termination **12** with aperture **14** as depicted in FIG. 1A bonded to a bolster **16** prior to fastener insertion to form hydro-form tube/bolster assembly **18** according to an embodiment of the invention. FIG. 2B is a side perspective view of the bonded hydro-form tube/bolster assembly **18** of FIG. 2A joined with a vehicle frame member **20**. FIG. 3A is a sectional view along line B-B through the flattened end termination **12** with aperture **14** of the hydro-form tube **10** bonded to the unitary piece bolster **16** of FIG. 2A with an adhesive **22**. FIG. 3B is a sectional view along line B-B through the flattened end termination **12** with aperture **14** of the hydro-form tube **10** joined to the bolster **16** of FIG. 2A with a fastener **24**. FIG. 4 is a perspective view of the bonded hydro-form tube/bolster assembly **18** of FIG. 2A having two opposing bonding surfaces **19** along a top surface **21** and having a portion **23** extending substantially perpendicular to the top surface. The bolster **10** having a central section **25**, the central section **25** adapted to insert within said bolster **18**. FIGS. 5A-5E are a series of sectional views along line C-C through a portion of the bolster **16** as shown in FIG. 4 showing the high strength plastics and composites used to form the bolster **16**. FIG. 5A illustrates a high strength plastic forming the bolster **16**. FIG. 5B illustrates sheet molding compounds (SMC) forming the bolster **16**. FIG. 5C illustrates bulk

4

molding compounds (BMC) forming the bolster **16**. FIG. 5D illustrates glass mat thermoplastic (GMT) forming the bolster **16**. FIG. 5E illustrates direct long fiber thermoplastic (DLFT) forming the bolster **16**.

The foregoing description is illustrative of particular embodiments of the invention, but is not meant to be a limitation upon the practice thereof.

The invention claimed is:

1. A vehicle assembly comprising:

a bolster having two opposing bonding surfaces along a top surface and having a portion extending substantially perpendicular to the top surface, where said bolster is formed of sheet molding compound, bulk molding compound, glass mat thermoplastic, or direct long fiber thermoplastic;

a hydro-formed reinforcement tube with a circular cross-section along a central section, the central section adapted to insert within said bolster, where said hydro-formed reinforcement tube has two flattened terminal ends both curving backwards relative to the central section and adapted to each contact one of the two opposing bonding surfaces with one or more apertures therein for integrated attachment to said bolster with mechanical fasteners; and

an adhesive bonding each of the two flattened terminal ends to one of the two opposing bonding surfaces wherein said vehicle assembly is a front end cross car component joined to a vehicle frame.

2. The assembly of claim 1 wherein said vehicle assembly is load bearing.

3. The assembly of claim 1 wherein said hydro-formed reinforcement tube is formed from at least one of aluminum, brass, carbon, steel, stainless steel, copper, and high strength alloys.

4. The assembly of claim 1 wherein said bolster is a unitary piece and formed of SMC.

5. The assembly of claim 1 wherein said bolster is a unitary piece and formed of glass mat thermoplastic.

6. The assembly of claim 1 wherein said bolster is a unitary piece and formed of direct long fiber thermoplastic.

* * * * *